



## Features

- Low voltage operation
- Low current consumption
- Fast response time
- I<sup>2</sup>C communication protocol
- Reliable capacitive technology
- Relative humidity accuracy of ±2 % (Typical)

## Applications

Industrial:

- HVAC systems
- Process monitoring
- Climate monitoring, interior and exterior

\*\*Medical Devices (low/medium risk):

- Diagnostic equipment
- Analysis equipment

# BPS240 Series - 2 mm Humidity Sensor

### Absolute Maximum Ratings

|                                   |                          |
|-----------------------------------|--------------------------|
| Supply Voltage ( $V_{CC}$ )       | -0.3 to 7.0 V            |
| Input Voltage ( $V_I$ )           |                          |
| CE                                | -0.3 to $V_{CC} + 0.3$ V |
| SCL/SDA                           | -0.3 to 7.0 V            |
| Output Voltage ( $V_O$ )          | -0.3 to $V_{CC} + 0.3$ V |
| Hi-level Output Current (IOH)     |                          |
| 1 Terminal                        | -5 mA                    |
| All Terminals Total               | -20 mA                   |
| Low-level Output Current (IOL)    |                          |
| 1 Terminal                        | 5 mA                     |
| All Terminals Total               | 20 mA                    |
| Operating Temperature ( $T_a$ )   | -40 °C to +105 °C        |
| Storage Temperature ( $T_{stg}$ ) | -50 °C to +125 °C        |

### Additional Information

Click these links for more information:



### Recommended Operating Conditions

|   |                      |
|---|----------------------|
| Power Supply Voltage ( $V_{CC}$ )                   | 1.62 to 5.5 VDC      |
| Capacitance between $V_{CC}$ and $V_{SS}$ ( $C_p$ ) | 0.1 $\mu$ F typical  |
| Pull Up Resistor Value on SDA <sup>1</sup> (R1)     | 5 k $\Omega$ typical |
| Pull Up Resistor Value on SCL <sup>1</sup> (R2)     | 5 k $\Omega$ typical |

<sup>1</sup> Select the resistance value to meet AC characteristics.

### Electrical Characteristics

|   |                  |
|---|------------------|
| Humidity Detection  |                  |
| Measurement Range   | 0 to 100 % RH    |
| Resolution (10-bit)   | 0.1 % RH typical |
| Humidity Accuracy - Typical (see Humidity Sensor Accuracy Graph for Maximum Rating) |                  |
| @ 25 °C (20 to 80 % RH)   | ±2 % RH          |
| @ 5 °C to 45 °C (0 to 100 % RH)   | ±4 % RH          |
| Hysteresis @ 5 °C to 45 °C (0 to 100 % RH)  |                  |
| Response Time   | ± 1 % RH typical |
| Reach ( $\tau$ 63 % @ 25 °C, wind velocity @ 1.0 m/s)                               | 1 second         |

Unless otherwise specified:  $V_{CC} = 1.62$  to  $5.5$  V,  $V_{SS} = 0$  V,  $T_a = -30$  °C to  $100$  °C

|  |                   |
|--|-------------------|
| Temperature Detection  |                   |
| Measurement Range  | -30 °C to +100 °C |
| Resolution (11 bit)  |                   |
| -30 °C to +100 °C  | 0.1 °C            |
| Temperature Accuracy   |                   |
| @ 5 °C to 60 °C  | ± 0.3 °C          |
| @ -20 °C to 85 °C  | ± 1.0 °C          |
| Reproducibility @ -30 °C to 100 °C                                     | ± 0.1 °C          |
| Response Time  |                   |
| Reach ( $\tau$ 63 % (dependent on surrounding heat conduction NOTE 1)) | 30 seconds        |

Unless otherwise specified:  $V_{CC} = 1.62$  to  $5.5$  V,  $V_{SS} = 0$  V,  $T_a = -30$  °C to  $100$  °C

NOTE 1 Extended exposure to >90 % RH causes a shift of up to 3 % RH which is reversible after a period of 14 days.

### Current Consumption

|                                  |   |
|----------------------------------|---|
| Sleep Current (CE=0, Sleep Mode) | 10 nA typical, 400 nA maximum           |
| Average Operating Current        | 4.8 $\mu$ A typical, 10 $\mu$ A maximum |

Unless otherwise specified:  $V_{CC} = 1.62$  to  $5.5$  V,  $V_{SS} = 0$  V,  $T_a = 0$  °C to  $60$  °C

\* RoHS3 Directive 2015/863 Amendments of Annex II on March 31, 2015

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# BPS240 Series - 2 mm Humidity Sensor



## Input/Output Terminal Characteristics

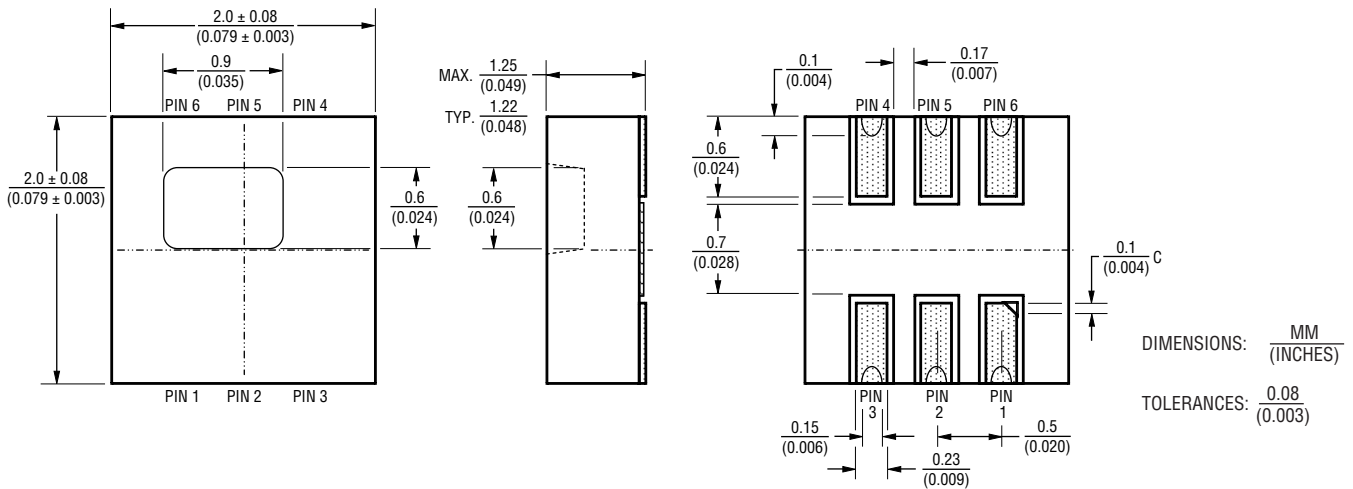
|  |   |
|--|---|
| High Level Input Voltage 1 (VIH1) [Target Terminal: SCL, SDA]                                  | .....0.7 V <sub>CC</sub> minimum, V <sub>CC</sub> maximum |
| High Level Input Voltage 2 (VIH2) [Target Terminal: CE]  | .....0.8 V <sub>CC</sub> minimum, V <sub>CC</sub> maximum |
| Low Level Input Voltage 1 (VIL1) [Target Terminal: SCL, SDA]                                   | .....V <sub>SS</sub> minimum, 0.3 V <sub>CC</sub> maximum |
| Low Level Input Voltage 2 (VIL2) [Target Terminal: CE]   | .....V <sub>SS</sub> minimum, 0.2 V <sub>CC</sub> maximum |
| Low Level Output Current (IOL) [VOL = 0.1 V <sub>CC</sub> , Target Terminal: SCL, SDA]         | .....0.5 mA minimum                                       |
| Terminal Leak Current 1 (IL1) [Terminal voltage = V <sub>CC</sub> , Target Terminal: SCL, SDA] | .....± 1 μA   |
| Terminal Leak Current 2 (IL2) [Terminal voltage = 0 V, Target Terminal: SCL, SDA, CE]          | .....± 1 μA   |
| Input Pull-Down Resistance (RPD) [Terminal voltage = V <sub>CC</sub> , Target Terminal: CE]    | .....60 kΩ minimum, 150 kΩ typical, 450 kΩ maximum        |

Unless otherwise specified: V<sub>CC</sub> = 1.62 to 5.5 V, V<sub>SS</sub> = 0 V, T<sub>a</sub> = -30 °C to 100 °C

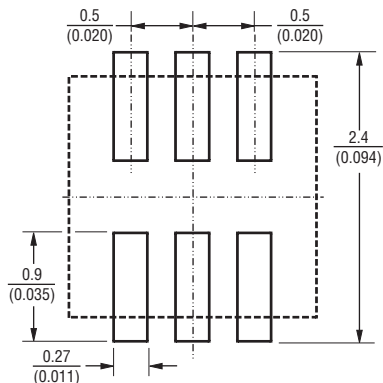
## Product Characteristics

|                            |                                 |
|----------------------------|---------------------------------|
| Moisture Sensitivity Level | .....1                          |
| ESD Classification (HBM)   | .....1 kV                       |
| Marking                    | ..... <b>B</b> , Date Code      |
| Standard Packaging         | .....2,000 pcs. per 7-inch reel |
| Weight                     | .....10.45 milligrams           |

## Product Dimensions



## Recommended PCB Layout



## Terminal Assignment

| No. | Terminal Name   | Function                                  |
|-----|-----------------|---|
| 1   | CE              | Chip enable terminal                      |
| 2   | V <sub>SS</sub> | Power supply terminal (-)                 |
| 3   | V <sub>CC</sub> | Power supply terminal (+)                 |
| 4   | V <sub>DD</sub> | Internal constant voltage output terminal |
| 5   | SDA             | I <sup>2</sup> C serial data              |
| 6   | SCL             | I <sup>2</sup> C serial clock             |

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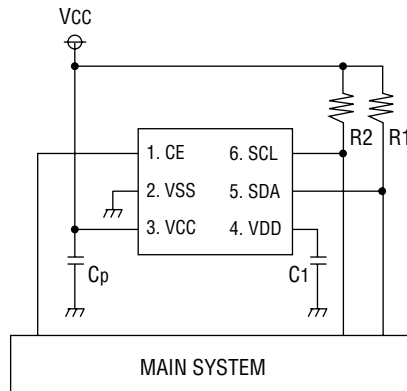
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# BPS240 Series - 2 mm Humidity Sensor

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## Basic Circuit Schematic



C<sub>p</sub> ..... 0.1 μF  
 C1 ..... 0.47 μF  
 R1-R2 ..... 5k Ω

NOTE: R1 and R2 are reference values. Resistor values should be selected to meet the AC characteristics.

## Operation Mode

| Operation Mode | Terminal Setup | Operation State of Each Functional Block |              |             |                 |                       |                   |                      |
|----------------|----------------|--|--------------|-------------|-----------------|-----------------------|-------------------|----------------------|
|                | CE             | V <sub>pp</sub>                          | Power Supply | Oscillation | Temp. Detection | Capacitance Detection | OTP Memory        | I <sup>2</sup> C-Bus |
| Sleep *1       | 0              | NC                                       | Stop         | Stop        | Stop            | Stop                  | Stop              | Stop                 |
| Standby        | 1              | NC                                       | Operation    | Operation   | Stop            | Stop                  | Read-out Possible | Operation            |

\*1 In case of power control mode, there is no sleep operation.  
 I<sup>2</sup>C slave address (SADR) is defined as "111 1111" (7Fh).

## Control Register Map

| Address | Bit                   | Bit Name                              | Function                           | Value                | Read-Out              | Write-In | R/W | Init. |
|---------|-----------------------|---------------------------------------|------------------------------------|----------------------|-----------------------|----------|-----|-------|
| 00h     | D7-1                  | -                                     | Reserved                           | -                    |                       |          | R   | 0     |
|         | D0                    | RESET                                 | Reset                              | 0                    | Normal Operation      | None     | R/W | 0     |
| 1       |                       |                                       |                                    | -                    | Reset Action          |          |     |       |
| 01h     | D7-6                  | MANMODE                               | Manual Detection Mode              | 00                   | Normal Operation Mode |          | R/W | 0     |
|         | D5-3                  | HAVE[2:0]                             | Humidity Detection Value Avg. Mode | 000                  | No Averaging Process  |          |     |       |
|         |                       |                                       |                                    | 001                  | 2 Times Average Mode  |          |     |       |
|         |                       |                                       |                                    | 01x                  | 4 Times Average Mode  |          |     |       |
|         |                       |                                       |                                    | 1xx                  | 8 Times Average Mode  |          |     |       |
| D2      | TAVE                  | Temperature Detection Value Avg. Mode | 0                                  | 8 Times Average Mode |                       | R/W      | 0   |       |
| 1       | 16 Times Average Mode |                                       |                                    |                      |                       |          |     |       |

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**Control Register Map (Continued)**

| Address | Bit  | Bit Name | Function  | Value          | Read-Out                  | Write-In                  | R/W | Init. |
|---------|------|----------|---|----------------|---------------------------|---------------------------|-----|-------|
| 01h     | D1   | -        | Reserved  | -              |                           |                           | R   | 0     |
|         | D0   | MAN      | Manual Detection Mode   | 0              | Standby State             | Detection Operation Stop  | R/W | 0     |
|         |      |          |   | 1              | Under Detection Operation | Detection Operation Start |     |       |
| 03h     | D7-1 | -        | Reserved  | -              |                           |                           | R   | 0     |
|         | D0   | ERR      | Manual Detection Error Flag   | 0              | No Error                  | Nothing is Done           | R/W | 0     |
| 1       |      |          |   | Error Occurred | Error Flag Reset          |                           |     |       |
| 04h     | D7-0 | HC[7:0]  | Humidity Detection Result<br><i>(After Correction Operation)</i>    | 000h-3FFh      |                           |                           | R   | X     |
| 05h     | D7-2 | -        | Reserved  | -              |                           |                           | R   | 0     |
|         | D1-0 | HC[9:8]  | Humidity Detection Result<br><i>(After Correction Operation)</i>    |                |                           |                           | R   | X     |
| 06h     | D7-0 | TC[7:0]  | Temperature Detection Result<br><i>(After Correction Operation)</i> | 000h-7FFh      |                           |                           | R   | X     |
| 07h     | D7-3 | -        | Reserved  | -              |                           |                           | R   | 0     |
|         | D2-0 | TC[10:8] | Temperature Detection Result<br><i>(After Correction Operation)</i> |                |                           |                           | R   | X     |
| 0Ah     | D7-0 | K[7:0]   | Capacity Detection Result<br><i>(Before Correction Operation)</i>   | 000h-FFFFh     |                           |                           | R   | 0     |

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**Control Register Map (Continued)**

| Address | Bit           | Bit Name                             | Function   | Value          | Read-Out                    | Write-In        | R/W | Init. |
|---------|---------------|--------------------------------------|--|----------------|-----------------------------|-----------------|-----|-------|
| 0Bh     | D7-0          | K[15:8]                              | Capacity Detection Result<br><i>(Before Correction Operation)</i>                              |                |                             |                 | R   | 0     |
| 2Ch     | D7-5          | -                                    | Reserved   | -              | -                           |                 | R   | 0     |
|         | D4            | SCR_ON_R                             | Standard Capacity Connection Control   | 0              | Outside Capacity Cutting    | R/W             | 0   |       |
|         |               |                                      |  | 1              | Outside Capacity Connection |                 |     |       |
| D3-0    | SCI_ON_R[3:0] | Internal Capacity Connection Control | 0h~Fh x 0.6 pF<br>Example:<br>At the time of 8 hours,<br>access to internal capacity of 4.8 pF |                | R/W                         | X               |     |       |
| 03h     | D7-1          | -                                    | Reserved   | -              |                             |                 | R   | 0     |
|         | D0            | ERR                                  | Manual Detection Error Flag  | 0              | No Error                    | Nothing is Done | R/W | 0     |
| 1       |               |                                      |  | Error Occurred | Error Flag Reset            |                 |     |       |

**Transfer Function Formula**

**Humidity**

$$RH = \frac{100}{2^{10}} \times RH_{IC} \quad (0 \sim 100 \% RH)$$

RH<sub>IC</sub> : IC Humidity Output Data (10 bit)

Refer to Register Map:

RH<sub>IC</sub> = Data of the addresses 04H and 05H (000h ~ 3FFh)  
It changes into a decimal and is operation.

**Temperature**

$$T = [T_{IC} - (2^{10} - \frac{25}{0.1})] \times 0.1 \quad (-30 \sim 100 \text{ }^\circ\text{C})$$

T<sub>IC</sub> : IC Temperature Output Data (11 bit)

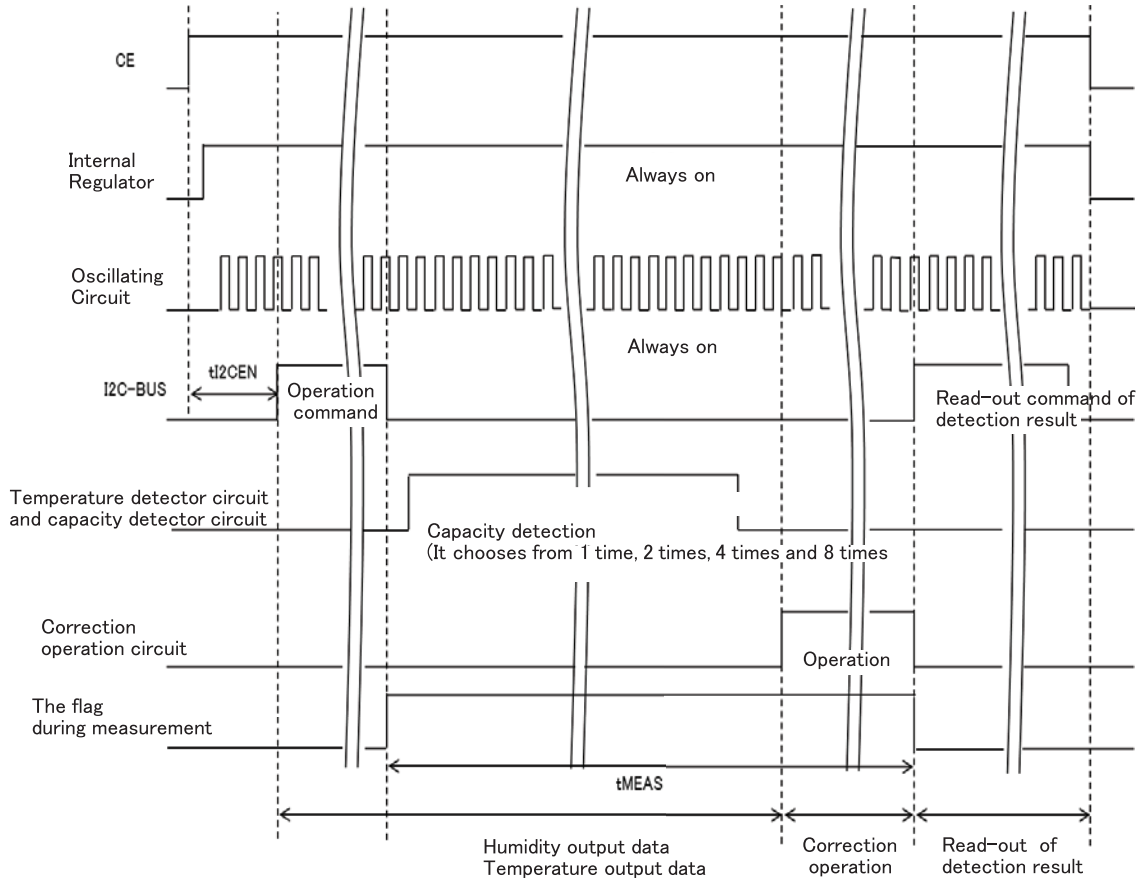
Refer to Register Map:

T<sub>IC</sub> = Data of the addresses 06H and 07H (000h ~ 7FFh)  
It changes into a decimal and is operation.

# BPS240 Series - 2 mm Humidity Sensor

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## Capacitance/Temperature Detection Sequence



## How To Order

**BPS240 - D 2P0 - S 10 E**

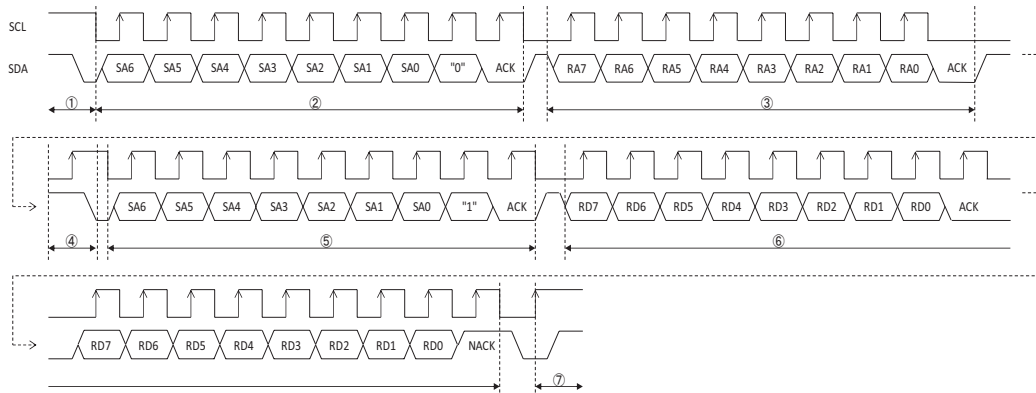
|                      |                                |
|----------------------|--------------------------------|
| Model Series         | Humidity-Temperature Sensor    |
| Output Type          | D = Digital                    |
| Accuracy (% RH)      | 2P0 = $\pm 2.0$                |
| Moisture Sensitivity | S = Standard                   |
| Resolution           | 10 = 10-bit                    |
| Packaging Designator | E = 2,000 pcs. per 7-inch Reel |

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## Output Type Waveform and Data Read/Write Procedure

### I<sup>2</sup>C-BUS Data Read-out Procedure

- ① I<sup>2</sup>C master device releases START condition.
- ② I<sup>2</sup>C master device transmits slave address and WRITE mode selection.
- ③ I<sup>2</sup>C master device transmits register address of this IC.
- ④ I<sup>2</sup>C master device releases repeated START condition. (Release method is same as START condition.)
- ⑤ I<sup>2</sup>C master device again transmits slave address and READ mode selection. (Read mode can be selected by transmitting "1" in 8th bit.)
- ⑥ I<sup>2</sup>C master device reads-out data from register address designated at ③.  
It is possible to read-out data while register address increments one, by reading-out multiple data continuously. However, during continuous read-out, please return ACK to this IC as a reply of master.
- ⑦ After the completion of all read-out, I<sup>2</sup>C master device releases STOP condition.



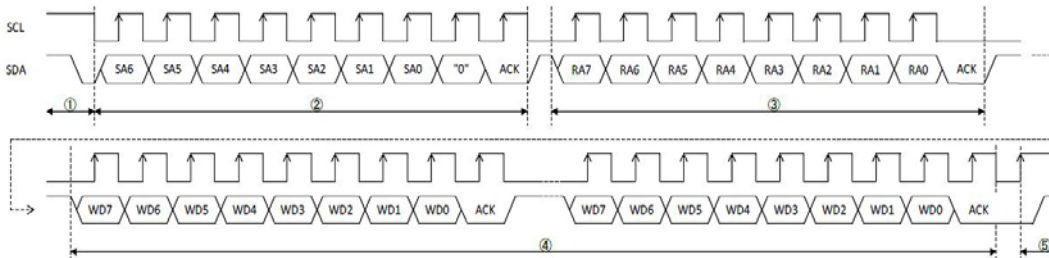
~ Continued ~

## Output Type Waveform and Data Read/Write Procedure (Continued)

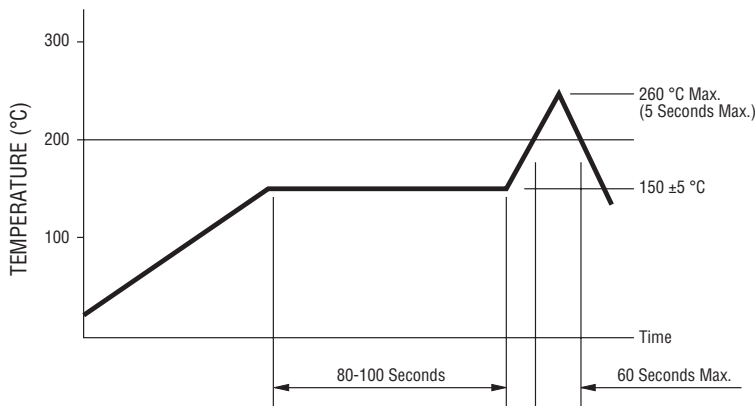
### I<sup>2</sup>C-BUS Data Write-in Procedure

- ① I<sup>2</sup>C master device releases START condition. (Start condition can be released by changing SDA from “H” to “L” while SCL is in “H” state.)
- ② I<sup>2</sup>C master device transmits slave address and WRITE mode selection. (Write mode can be selected by transmitting “0” in 8th bit while 1~7th bits are slave address.)
- ③ I<sup>2</sup>C master device transmits register address of this IC.
- ④ I<sup>2</sup>C master device transmits write-in data.
- ⑤ It is possible to write-in data while register address increments one, by transmitting multiple write-in data continuously.

After the completion of transmitting all write-in data, I<sup>2</sup>C master device releases stop condition. (Stop condition can be released by changing SDA from “L” to “H” while SCL is in “H” state.)



## Solder Profile



Processing Method: Reflow soldering with infrared heat or forced air convection (only once).

### Notes:

1. No clean solder paste is recommended.
2. Aqueous wash is not recommended.
3. Use of water soluble soldering flux should be avoided due to possible corrosion.
4. Multiple passes through the soldering process is not recommended.
5. Other SMD processes and profiles should be verified by the customer.

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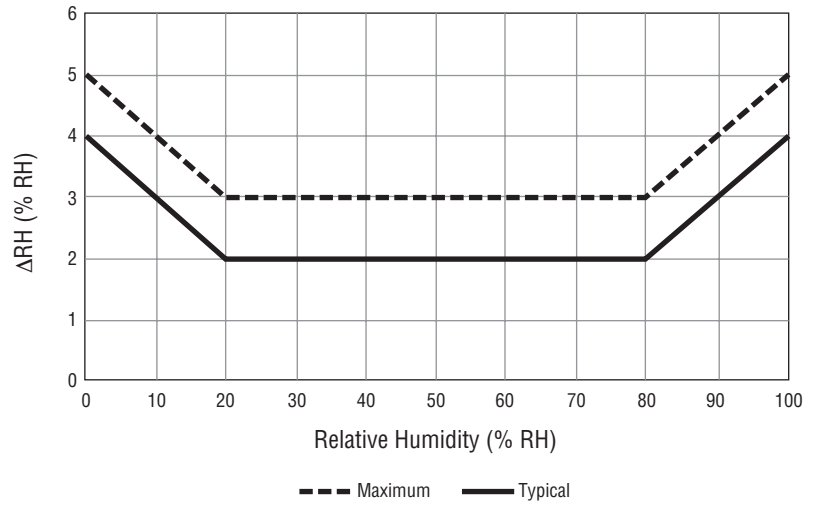


# BPS240 Series - 2 mm Humidity Sensor



## Humidity Sensor Accuracy

| Relative Humidity (% RH) | Maximum | Typical |
|--------------------------|---------|---------|
| 0                        | 5       | 4       |
| 10                       | 4       | 3       |
| 20                       | 3       | 2       |
| 30                       | 3       | 2       |
| 40                       | 3       | 2       |
| 50                       | 3       | 2       |
| 60                       | 3       | 2       |
| 70                       | 3       | 2       |
| 80                       | 3       | 2       |
| 90                       | 4       | 3       |
| 100                      | 5       | 4       |



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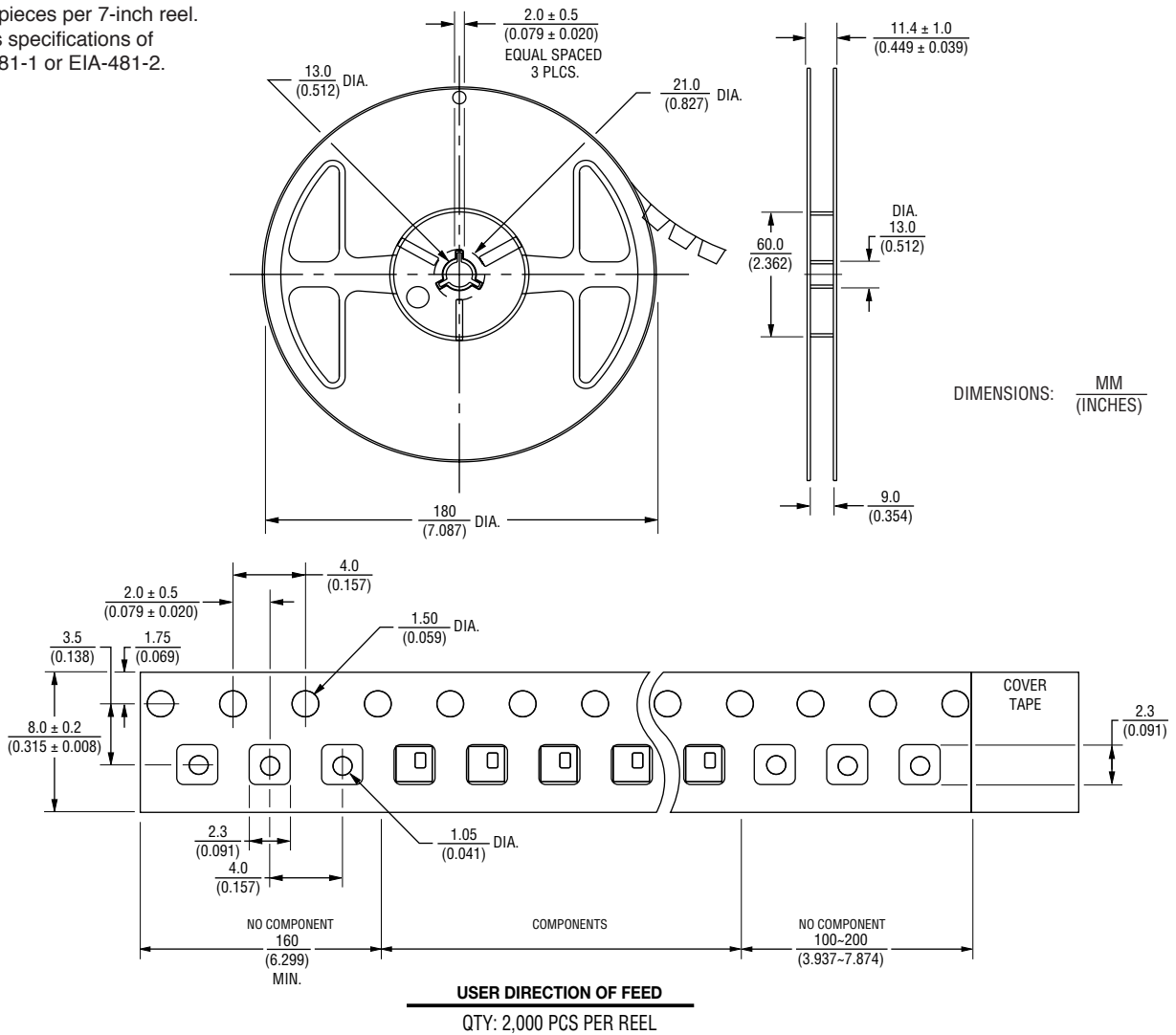
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## Packaging Specification

3000 pieces per 7-inch reel.  
Meets specifications of  
EIA-481-1 or EIA-481-2.



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